

Unit 2

Homeostasis in Organisms

1

Homeostasis

- The maintenance of a stable internal environment
 - Temperature
 - Water balance
 - pH

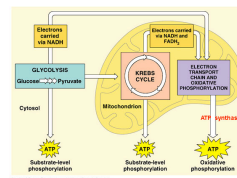
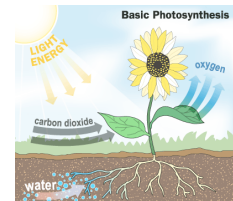


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Basic Biochemical Processes

- Chemical processes that occur in living organisms
- Require energy and raw materials to carry out biochemical processes
- 2 main processes we should consider
 - Photosynthesis
 - Cell respiration

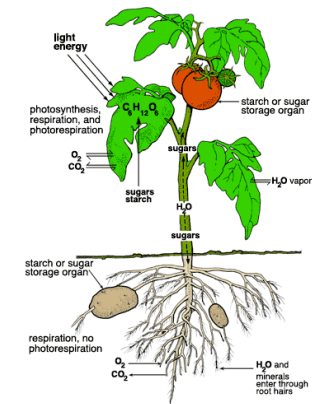


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Using Glucose

- Plants use glucose produced by photosynthesis in a few ways
 - For energy
 - As the main molecule of cell respiration to produce ATP
 - For building blocks of new growth

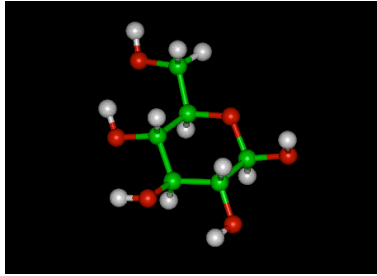


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Using Glucose to Produce Energy

- Glucose is the starting material of choice for cell respiration
- Production of ATP
- Chemical bonds in glucose are broken, and the energy is released to ATP, which is the main molecule of cellular energy
- ATP is used by all organisms

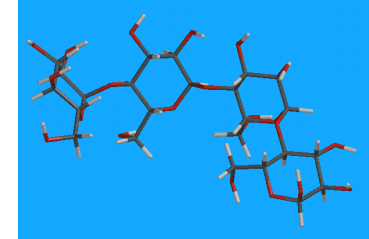


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Using Glucose as a Building Block

- Because glucose is a simple molecule it makes a nice brick for building more complex materials
- Synthesis
 - Different complex molecules can be produced, depending on the needs of the organism

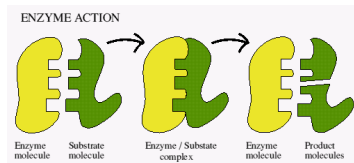


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Releasing Energy From Complex Molecules

- All living things need energy to survive and grow
- Energy in chemical bonds is not useful until the bonds are broken
- Enzymes** are vital to this digestion of large molecules (starch) to smaller components (glucose)

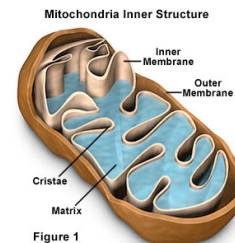


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The Role of Mitochondria

- Inside cells, the glucose is sent to the mitochondria, where it is further broken down
- Much of the energy is released if O_2 is present
 - Some is lost to the environment as heat
 - The rest is used to make ATP

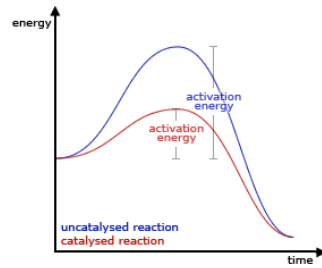


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More on Enzymes

- Also known as a catalyst
- Are not affected by the reaction they speed up, so they can be used more than once

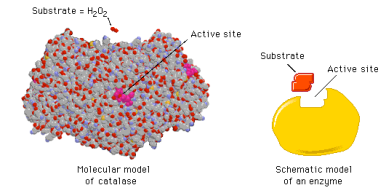


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Function of Enzymes

- Are known to affect many different biochemical pathways
- Synthesis
- Digestion
- Cellular Respiration
- Respiration (breathing)

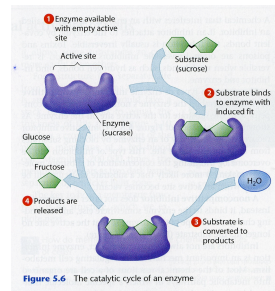


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Enzymes and Molecule Shape

- Most protein based molecules, like enzymes or hormones, rely heavily on their shape to allow them to react with other molecules, or with cells
- Enzymes are very selective. Only substrates that fit correctly will be acted upon

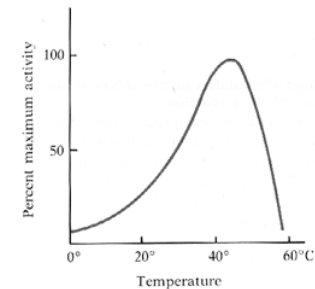


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Factors Affecting Enzymes

- Shape of substrate
- Temperature
 - Each enzyme has an optimal temperature at which it operates (most human enzymes operate at 37°C)
- pH (most human enzymes work best at about 7.0-7.4, except digestive)

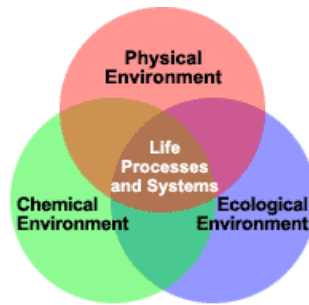


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Feedback and Homeostasis

- Homeostasis is constantly threatened in most organisms
- External environments are constantly changing
- Organisms must constantly sense and adjust

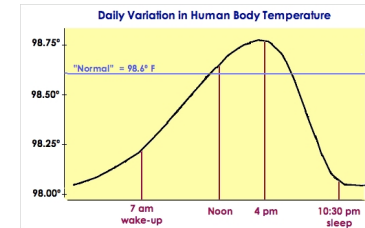


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Dynamic Equilibrium

- Small but continual modifications to maintain a relatively stable equilibrium
- Human body temperature rarely stays at exactly 37°C
 - It fluctuates up and down a degree or so all day long, so we consider it dynamic



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Feedback Mechanisms

- Organisms usually use a system of feedback to maintain their equilibrium
- When stimulus is detected, a response follows at both the cellular and organismal level to return the organism to the dynamic equilibrium state

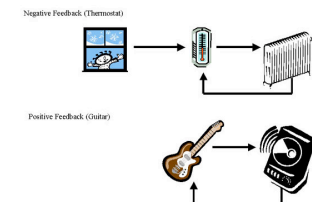


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Positive or Negative?

- The two main types of feedback mechanisms are positive feedback and negative feedback
- Some feedback mechanisms are learned, some are genetic

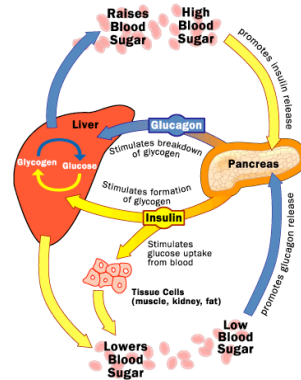


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Negative Feedback and Cells/Organ Systems

- Often, negative feedback requires interaction between individual cells and organ systems
- Glucose level is one example
- Cells monitor the condition/level of blood sugar, while the pancreas produces insulin to reduce blood sugar, or glucagon to increase blood sugar
- Guard cells in plants will change shape in response to water level in the plant to reduce or increase evaporation



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Disease as a Failure of Homeostasis

- Disease is any condition that prevents the body from functioning as it should
- Can be caused by infectious pathogens, or by faulty body systems, or exposure to poisonous/damaging chemicals

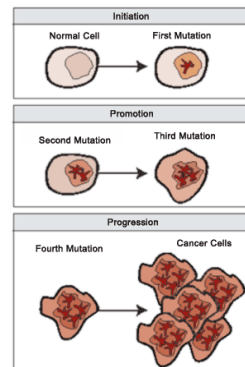
Cause of Disease	Examples
Inherited Disorders	Down Syndrome, Cystic Fibrosis, Sickle Cell Disease, Huntington's Disease
Exposure to Toxins	Lead poisoning, Radiation poisoning
Poor Nutrition	Scurvy (Vitamin C deficiency), Goiter (Iodine deficiency)
Organ Malfunction	Heart Attack, Diabetes
High-Risk Behaviors	Lung Cancer, Drug Addiction, Skin Cancer

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Cancer

- An uncontrolled growth of cells in any location within a body is called a cancer
- Cancers can arise from damage to normal cells by chemicals or radiation
- Tumors are lumps of cancerous cells

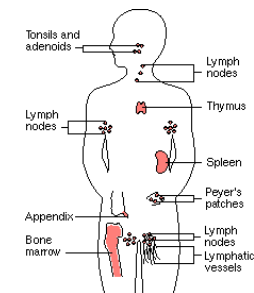


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The Immune System

- The body's primary defense against pathogens
- Most pathogens have surface antigens that identify them to the cells of the body
- Cells having the antigens that are not "self" are immediately attacked by the immune system

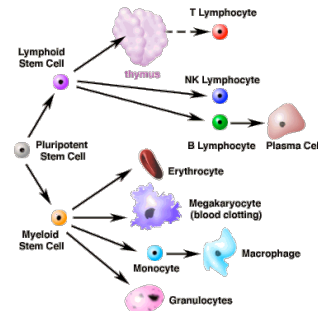


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White Blood Cells and Antibodies

- Our bodies have a variety of white blood cells
- Some are directly responsible for engulfing and destroying pathogens, others tag them with antibodies, marking them for destruction

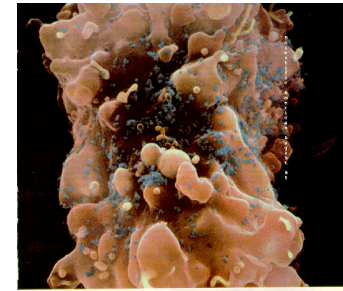


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Damage to the Immune System

- There are many diseases that can affect the immune system, but the major one worldwide is AIDS
- Targets white blood cells and reduces the ability of the body to fight off infection

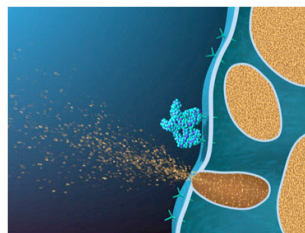


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Allergies

- Allergies are over-reactions of the immune system to antigens on normally harmless substances, like pollen
- Release of histamines



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Autoimmune Disorders

- Sometimes, the body's identification systems fail and cells that are "self" are not recognized and are attacked by the immune system
- Often happens after transplants as well



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This is Only a Spacer Slide

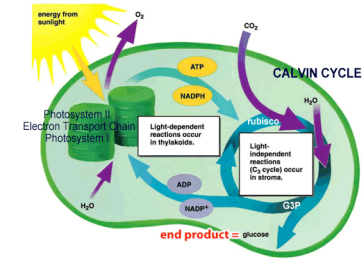
- Click back to start button to go back to the start. Bet you wouldn't have guessed that, eh?

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Photosynthesis

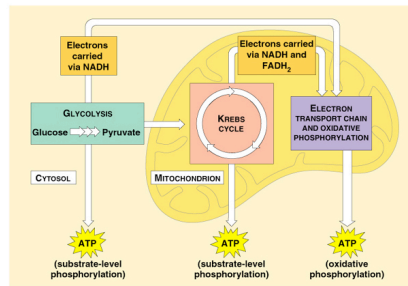
- Conversion of light energy into glucose by cells of producers
- Pigmented Chloroplasts
- Plants, algae, and some bacteria
- Use CO_2 and H_2O as source of raw materials to produce $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) and O_2 gas
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Cell Respiration

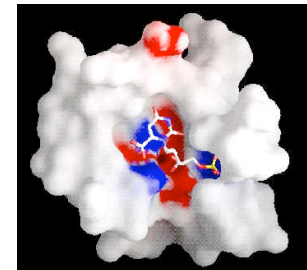
- Glucose is broken down in a multi-step process, releasing the energy contained in the bonds, releasing CO_2 and H_2O
- ATP is created, depending on how whether oxygen is present
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Enzymes

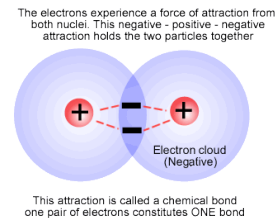
- Special proteins that affect the rate of chemical reactions in cells
- Are affected by temperature, pH, and concentration of enzyme and target molecule (substrate)
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Chemical Bonds

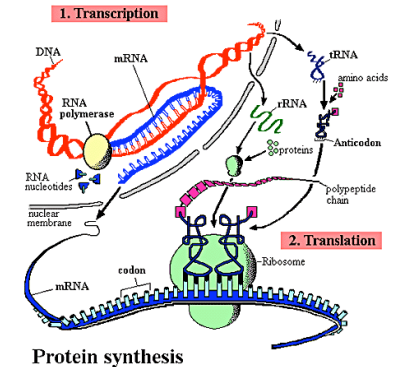
- When any two atoms are connected to one another, a chemical bond is formed
- Energy is bound up in the formation of most bonds because atoms don't like being tied together
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Synthesis

- The creation of new materials from simpler building blocks is called synthesis
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Complex Molecules and Their Use

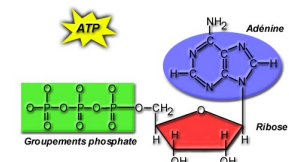
- Complex molecules created by synthesis within cells are used for a variety of functions by the cells
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Molecule	Function
ATP	Cellular energy
DNA	Hereditary Material
Carbohydrates	Source of energy; Short term storage of excess energy
Protein	Building blocks of cellular materials
Lipid	Source of energy; Long term storage of excess energy

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ATP

- Adenosine Triphosphate
- Main molecule of useable energy by cells
- Unlike glucose, can be quickly broken down to release energy when needed
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Positive Feedback

- ◁ A stimulus prompts a response, which leads to a stronger stimulus and therefore an even stronger response
- ◁ A continual cycle until the original stimulus is removed
- ◁ The labor contractions of early childbirth are a positive feedback system. When the baby's head touches the base of the uterus, contractions grow stronger and stronger until the child is born
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Negative Feedback

- ◁ The most common type of feedback system
- ◁ Usually the result of communication between one or more organ systems of the body
- ◁ Hypothalamus control of body temperature is an example (remember the home heating/furnace analogy?)
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Pathogens

Pathogen	Description	Example
Virus	Particles made up of a protein coat and genetic material. Can only reproduce inside host cells. Best treatment is rest. Antibiotics have no effect.	Common cold, HIV, Chicken Pox
Bacteria	Single-celled organisms that can reproduce rapidly when conditions are right. Treatable with antibiotics.	Food poisoning (Salmonellosis), Strep Throat, Syphilis
Fungus	Single or multi-cellular organisms. Include yeasts and molds. Not treatable by antibiotics, but anti-fungals work well.	Athlete's Foot, Ringworm
Parasites	Organisms that live off another organism, doing damage to the host by stealing resources from it.	Leeches, Tapeworms, Malaria

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Antigens

- ◁ Molecules on the surface of a cell or pathogen that can be used by the body to identify the cell as a threat
- ◁ Can be either protein or carbohydrate based
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Antibodies

- Specialized proteins that can either attack foreign cells or tag them and mark them for destruction by white blood cells of the body
- Antibodies that are tags match the antigens on the surface of the cell in question
- Some antibodies will remain for the life of the person, allowing very rapid response to future infections of the same pathogen
 - This is how vaccines work
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Histamines

- Chemicals released by cells that cause runny noses, sneezing, rashes, and sometimes swelling
 - Often can be severe, and sometimes fatal
- Antihistamines are used to prevent the action of the histamines
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